CLAIMS

1. A silicon single crystal pulling method comprising:

arranging an upper coil (51) and a lower coil (52) with a predetermined gap therebetween in a perpendicular direction outside a chamber (11) in which a quartz crucible (13) is provided;

generating a cusp magnetic field (53) having an intensity of 50 gausses or above which runs through a neutral plane (53a) between the upper coil (51) and the lower coil (52) from respective coil centers of the upper coil (51) and the lower coil (52) by allowing opposite currents to flow through the upper coil (51) and the lower coil (52);

rotating the quartz crucible (13) at a predetermined rotation speed;

supplying an inert gas into the chamber (11) from an upper part of the chamber (11) so that the inert gas flows down in a heat shielding member (36) provided in the chamber (11);

rotating a silicon single crystal ingot (25) including a top-side ingot (25a) and a bottom-side ingot (25b) from the silicon melt (12) at a predetermined rotation speed; and

pulling up the silicon single crystal ingot (25) from a center of the heat shielding member (36) at a pulling

rate with which a perfect region where interstitial silicon point defect agglomerates and vacancy point defect agglomerates do not exist is provided in the silicon single crystal ingot (25),

wherein the heat shielding member (36) comprises:

a cylindrical portion (37) whose lower end is positioned above a surface of the silicon melt (12) with a gap therebetween and which surrounds an outer peripheral surface of the ingot (25); and

a bulge portion (41) which is provided to bulge in an in-cylinder direction at a lower portion of the cylindrical portion (37) and has a heat storage member (47) provided therein,

wherein an inner peripheral surface of the heat storage member (47) is formed in such a manner that a height (H_1) is not smaller than 10 mm and not greater than d/2 and a minimum gap (W_1) with respect to the outer peripheral surface of the ingot (25) is not smaller than 10 mm and not greater than 0.2d where d is a diameter of the ingot (25) and not smaller than 100 mm, and

wherein a flow quantity of the inert gas flowing down between the bulge portion (41) and the ingot (25) when pulling up the top-side ingot (25a) of the silicon single crystal ingot (25) is larger than a flow quantity of the inert gas flowing down between the bulge portion (41) and the ingot (25) when pulling up the bottom-side ingot (25b) of the silicon single crystal ingot (25).

2. The silicon single crystal pulling method according to claim 1, wherein a flow rate index (S) obtained by the following Equation (1) of the inert gas flowing down between the bulge portion (41) and the ingot (25) when pulling up the top-side ingot (25a) is set higher than a flow rate index (S) obtained by the following Equation (1) of the inert gas flowing down between the bulge portion (41) and the ingot (25) when pulling up the bottom-side ingot (25b):

$$S = (Po/F) \times F/A \quad \ldots (1)$$

where Po is an atmospheric pressure (Pa) outside the chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow quantity (m^3/second) under the pressure Po (Pa) of the inert gas supplied to the chamber (11) in a room temperature state, and A is a cross-sectional area (m^2) between the bulge portion (41) and the silicon single crystal ingot (25).

3. A silicon single crystal pulling method comprising:

arranging an upper coil (51) and a lower coil (52) with a predetermined gap therebetween in a perpendicular direction outside a chamber (11) in which a quartz crucible (13) is provided;

generating a cusp magnetic field (53) which runs through a neutral plane (53a) between the upper coil (51)

and the lower coil (52) from respective coil centers of the upper coil (51) and the lower coil (52) by allowing opposite currents to flow through the upper coil (51) and the lower coil (52);

rotating the quartz crucible (13) at a predetermined rotation speed;

supplying an inert gas into the chamber (11) from an upper part of the chamber (11) so that the inert gas flows down in a heat shielding member (36) provided in the chamber (11);

rotating a silicon single crystal ingot (25) including a top-side ingot (25a) and a bottom-side ingot (25b) from the silicon melt (12) at a predetermined rotation speed; and

pulling up the silicon single crystal ingot (25) from a center of the heat shielding member (36) at a pulling rate with which a perfect region where interstitial silicon point defect agglomerates and vacancy point defect agglomerates do not exist is provided in the silicon single crystal ingot (25),

wherein the heat shielding member (36) comprises:

a cylindrical portion (37) whose lower end is positioned above a surface of the silicon melt (12) with a gap therebetween and which surrounds an outer peripheral surface of the ingot (25); and

a bulge portion (41) which is provided to bulge in an in-cylinder direction at a lower portion of the cylindrical

portion (37) and has a heat storage member (47) provided therein,

wherein an inner peripheral surface of the heat storage member (47) is formed in such a manner that its height (H_1) is not smaller than 10 mm and not greater than d/2 and its minimum gap (W_1) with respect to the outer peripheral surface of the ingot (25) is not smaller than 10 mm and not greater than 0.2d mm where d is a diameter of the ingot (25) and not smaller than 100 mm, and

wherein an intensity of the cusp magnetic field (53) when pulling up the top-side ingot (25a) of the silicon single crystal ingot (25) is set higher than an intensity of the cusp magnetic field (53) when pulling up the bottom-side ingot (25b) of the silicon single crystal ingot (25).